# Components in Long-Term, Comprehensive Care of Patients with Myofascial Pain Syndrome:

## Part II—The Usefulness of Biofeedback

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Pain is a symptom which suggests that the body has been injured. The sensation of pain is complex and is usually associated with emotional distress and sleep disorders. The neurophysiology of pain involves peripheral pain receptors; ascendent sensory pathways through the spinal cord, thalamus, and other areas of the limbic system; and the sensory cortical area of the brain. Patients with chronic myalgia may be diagnosed as having myofascial pain syndrome (MPS) and/or fibromyalgia.

### BIOFEEDBACK AND NEUROFEEDBACK FOR PAIN CONTROL

The use of general biofeedback in controlling pain levels has proved beneficial by means of relaxation response techniques. However, when the central nervous system is involved, neurofeedback is the preferred modality for training patients and achieves fast, long-lasting effects on pain control mechanisms. In conjunction with other therapeutic modalities, neurofeedback is effective for achieving pain control through operant conditioning. This technique brings essential changes in pain control by affecting the awareness of pain by the body and by modifying perceptions as influenced by emotions.

### MEASUREMENTS OF PAIN

Electromyography (EMG) is one of the modalities used to measure peripheral pain in general biofeedback. Other modalities are used to measure the effect of the emotions on pain and may encompass peripheral temperature and sweat gland activity (ie, skin conductance response [SCR]). The use of nuclear magnetic resonance spectroscopy convincingly demonstrates that muscle is not the primary factor in fibromyalgia. The latest studies now focus on the central nervous system as a factor. Spontaneous electroencephalography (EEG) and evoked response potentials (ERPs) are used as central measures of the pain experience as well as during neurofeedback or EEG biofeedback therapy.

### THE UCLA STUDY

At the UCLA Pain Medicine Center, 50 patients with chronic pain were referred for biofeedback training. Of these patients, 23 were previously diagnosed as having MPS with or without fibromyalgia. Overlapping symptoms or diagnoses that were recorded included high blood pressure, diabetes, and attention-deficit disorder (Table 1). Before receiving biofeedback training, some patients had been treated with all of the active therapies (ie, medical, surgical, electrical stimulation, etc) without experiencing a complete resolution of pain (Table 2).

**Table 1. Overlapping Symptoms and Diagnoses in Patients with Chronic Pain**

| |
|---|
| High blood pressure |
| Diabetes |
| Asthma |
| Anxiety and/or depression |
| Sleep disorders |
| Attention-deficit disorder |
| Epilepsy |
| Parkinson's disease |
| Addiction |

**Table 2. Active Therapies for Chronic Pain**

| |
|---|
| Medical treatment (oral or parenteral) |
| Surgery |
| Electrical stimulation |
| Chiropractic and physical therapy |
| Acupuncture |
| Herbal medicine |

**Table 3. Standardized Evaluation and Reevaluation Procedure for Patients with Chronic Pain Syndromes**

- Referral from a primary physician and/or psychotherapist
- Complete questionnaire containing:
  - — Chief complaint and associated symptomatology
  - — History of symptomatology
  - — Personal medical history; family history
  - — Present and past therapies including medications
  - — Pain level during examination (description of pain characteristics: exacerbated, diminished, etc)
  - — Chronic fatigue syndrome questionnaire, headache questionnaire
- Psychophysiologic profile (PPP)
  (using Biocomp with multiple modalities)
- Muscle exercises recording EMG and pain fluctuations around trigger points (using Biocomp with EMG)
- Electroencephalography evaluation (spontaneous EEG using Neurocybernetics)
- Cognitive functioning testing
  - — Test of Variables of Attention (TOVA)
  - — Memory Assessment Scale (MAS)
- Biofeedback training
  - — Use of one or more modalities according to results of evaluation
  - — Sessions conducted 1-3 times per week for at least 20 sessions, followed by reevaluation

## Methodology and Instruments

Before receiving biofeedback training, every patient underwent an evaluation using a standardized protocol (Table 3). Instruments used for the protocol included the Biocomp Psychophysiologic Profile (PPP) (Biocomp Research; Culver City, Calif) and the Neurocybernetics EEG (EEG Spectrum, Inc; Encino, Calif). The PPP evaluates changes in general muscle reactivity (EMG), peripheral temperature (TMP), and sweat gland activity (SCR) through a standardized questionnaire. The EMG records muscle tension, spasms, fibrillations, or relaxation around tender points (TePs) and trigger points (TrPs) in fibromyalgia and MPS, respectively.

The 10/20 international system for electrodes positioning was implemented for the EEG. The main positions or conditions evaluated by EEG were the central area of the brain, top of the sensory motor strip, eyes open and closed, select mental activities, or incited emotional responses. The evaluation focused on the predominance of particular brain wave frequencies, pathologic brain waves, spikes, rhythmic activity, and other patterns of activity. In cases where cognitive functions had been reported as being impaired, cognitive functioning tests (Test of Variables of Attention [TOVA] and Memory Assessment Scale [MAS]) were administered to obtain a baseline before commencement of training.

After completion of the pretreatment evaluation, biofeedback training using one or more modalities selected on the basis of the evaluation results (Table 4) was taught at a frequency of one to three sessions per week for at least 15 sessions. Study investigators had concluded that 15 to 20 sessions were necessary and sometimes sufficient to accomplish complete and permanent control over pain. The training also involved adjunct therapies such as the relaxation response, breathing exercises, other behavioral modification techniques, and modified diet (Table 5). At the conclusion of training, the patients were reevaluated.

## Results

Our experience in using biofeedback training at UCLA Pain Medicine Center has been rewarding. A total of 9 patients from the group of 23 patients diagnosed as having MPS had undergone at least 15 sessions of biofeedback training and reported improvement in pain intensity compared with baseline levels at the start of training (Tables 6 and 7). Sleep disorders and emotional distress (anxiety and depression), which often were concomitant symptoms, also improved as a result of biofeedback training (Table 6).

**Table 4. Biofeedback Therapies for Chronic Pain**

- Peripheral measures of pain
  - — Electromyography (EMG) = Muscle tension/spasms
  - — Cardiovascular = Temperature (TMP)
    = Photoplethysmography
    = Heart rate/Blood pressure
  - — Skin conductance response (SCR) = Sweat gland activity
- Central measures of pain
  - — Spontaneous electroencephalography (EEG)
  - — Evoked response potential (ERP)

**Table 5. Adjunct Therapies to Biofeedback for Chronic Pain**

- Relaxation techniques
  - — Autogenic training
  - — Progressive relaxation
  - — Quieting response
- Breathing exercises
- Continual feedback with pain diary, level of sensation/level of distress pacing, activities chart, blood pressure chart, etc
- Diet

**Table 6. Patient Enrollment and Outcome Measures in UCLA Pain Study on Biofeedback for Chronic Pain**

- Total number of patients with chronic pain referred for biofeedback = 50
- Total number of patients with myofascial pain syndrome = 23
- Total number of patients with MPS trained for more than 15 sessions who showed improvement = 9
- Improvement determined by:
  - — Reduction of pain intensity, duration, and occurrence
  - — Modification of associated symptoms
    - Reduction of anxiety or depression
    - More restorative sleep
    - Greater control over blood pressure, etc
- Reduction in medications needed
- Higher quality of life overall

**Table 7. Profile of 9 Patients with Chronic Pain/Myofascial Pain Syndrome Responding to Biofeedback**

| No. | Name | Age (yr) — Sex | Primary Diagnosis | Secondary Diagnosis | Previous Types of Therapy* | No. Sess. | Pain Sleep Emotions |
|---|---|---|---|---|---|---|---|
| 1 | C. L. | 50 — F | RSD Facial nerve neuralgia MPS | Depress. Sleep d. | 6 Medications Surgery Electric. stimul. | 15 EEG | 10 /2-1 |
| 2 | R. E. | 43 — F | MPS / Headaches | Depress. Anxiety | 10 Medications | 20 EEG | 9-4 /1-0 |
| 3 | M. A. E. | 51 — F | MPS | Bruxism Sleep d. Anxiety | 7 Medications | 20 EMG/ EEG | 9-4 /2-3 |
| 4 | A. D. | 60 — M | FLBPS MPS Neuropathy | HBP/ Diabetes | 7 Medications 5 Surgeries Electric. stimul. | 26 EEG/ EMG | 8-10 /0-1 |
| 5 | O. W. | 41 — M | SCI/Head MPS | ADD/ Memory problem | 3 Medications 3 Surgeries Physical therapy | 30 EEG | 9-10 /0-4 |
| 6 | A. R. | 41 — F | MPS/FM | Carpal tunnel s. Sleep d. | 1 Medication Physical therapy | 15 EEG | 8 /2-0 |
| 7 | F. E. | 48 — F | Neck pain/ MPS | Anxiety Depress. | 2 Medications Physical therapy Acupuncture | 21 EEG | 8 /1-0 |
| 8 | H. J. | 52 — M | Neck/Shoulder pain/MPS | Depress. Anxiety | 4 Medications Physical therapy Acupuncture 3 Surgeries | 22 EEG | 8 /2-1 |
| 9 | T. G. | 42 — M | Abdominal p./inguinal postsurgery/ MPS | Sleep d. | 2 Medications | 4 TMP 13 EEG | 10 /3-2 |

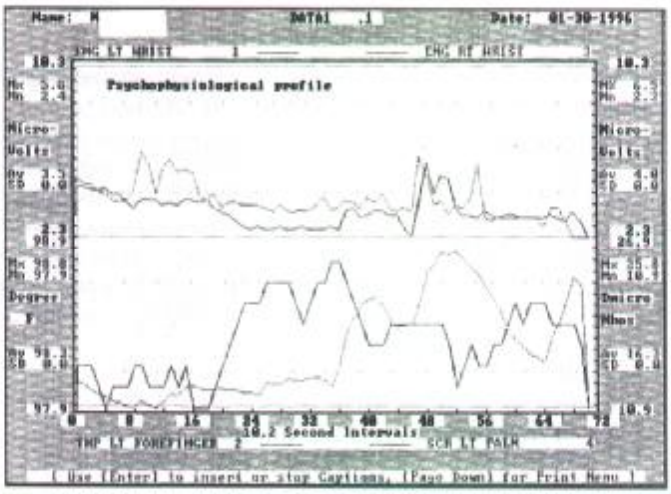
* Medical therapy comprised various combinations of pain alleviators, antidepressants, and sedatives in the majority of cases. Some female patients were receiving concomitant hormonal therapy for menopause.

## Case Studies

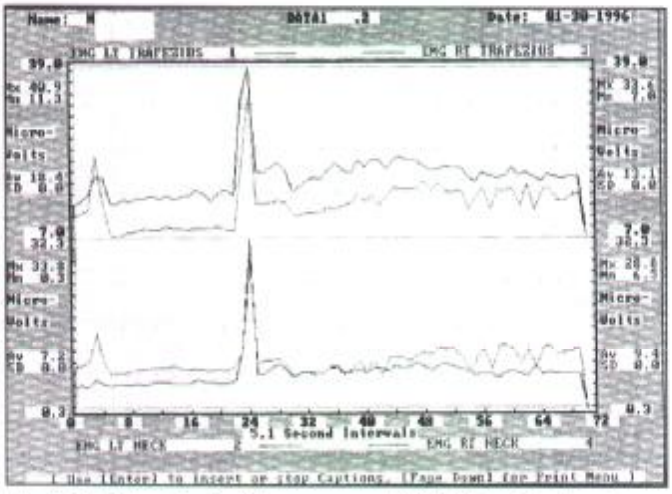
*Case 1.* M.A.E., a 51-year-old white female with MPS, sleep disorder, and bruxism, was referred for biofeedback. Before the evaluation, this patient was prescribed a series of pain alleviators, antidepressants, and sedatives, as well as hormonal supplements to control symptoms associated with menopause (Table 7, patient No. 3). Dental therapy was performed in parallel to the biofeedback therapy. The pain, which was variable in intensity (4-9 on pain scale), was mainly localized on the left temporomandibular region, left side of neck, and left shoulder; tingling of the left hand was also reported. A history of a head injury due to a car accident was taken into consideration.

The PPP showed that this patient responded in a normal manner to the stressor/relaxation evaluation (Graph 1). A significant degree of spasticity and slow recovery of the left trapezius were observed (Graph 2). Evaluation of the temporomandibular joint (TMJ) showed no difference between the right and left TMJ (Graph 3); exercises directed to the TMJ did not increase the pain intensity. Likewise, the manipulation of trigger points did not modify the perception of pain; only a slight increase in pressure inside the ear canal was noted, although the patient commented that "the pain may come later on." Teeth grinding during the night and day was considered indicative of a sleep disorder and a low level of arousal. In contrast, the EEG showed great variability in the brain waves and great asymmetry between the right and left hemisphere: high amplitudes of low frequency (theta, 4-7 Hz) and higher frequency (beta, 15-18 Hz), with variations of the high beta amplitude (20-32 Hz) on the right side at the C4 position (Graph 4).

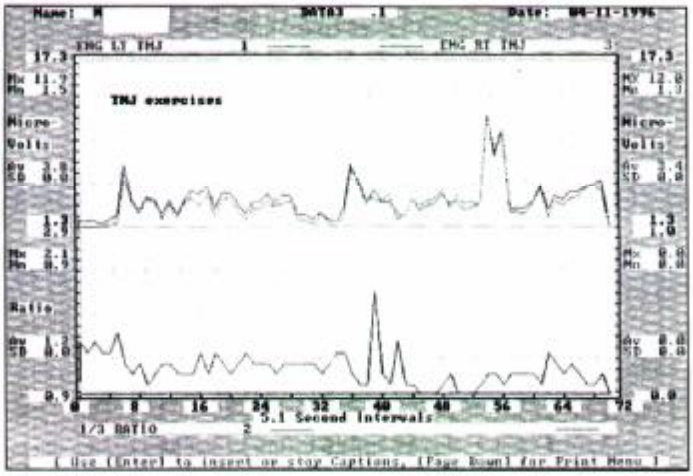
Biofeedback training for this patient focused on the regulation of the EEG brain waves, mainly on the right side, with parallel EMGs recommended by the patient's health insurance carrier. During training, the patient was instructed to keep a daily diary of pain/distress levels and to practice the relaxation response, quieting response, and breathing exercises. After 20 sessions of EEG and EMG, sometimes performed concomitantly, the patient felt an improvement in pain control and in the quality of sleep. The intensity of pain was recorded at the beginning and end of each session, with postsession recordings always showing a significant lowering of the pain intensity. The EEG brain waves indicated only a slight asymmetry, but the right-sided EEG showed normalization (Graph 5). Improvements in the quality of sleep were considered to be the result of normalization of the EEG patterns. This patient mentioned that simple muscle relaxation was not enough to control the way that her mind perceived the pain. Alteration of this patient's perceptions could be accomplished only by EEG training.



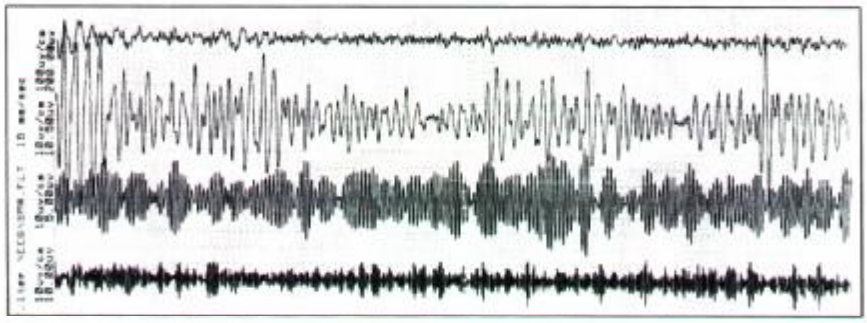

***Graph 1.*** *Patient No. 3. Psychophysiologic profile analyzed on Biocomp instrument. Upper Panel, General muscle tension and reactivity to standardized questionnaire by monitoring surface electromyography (EMG) wrist to wrist, expressed in microvolts of EMG activity (left wrist, darker line; right wrist, lighter line). Lower Panel, Autonomic nervous system reactivity tested by peripheral blood flow (temperature, darker line), and sweat gland activity (skin conductance response, lighter line). Observe normal reactivity to stress and induced relaxation.*



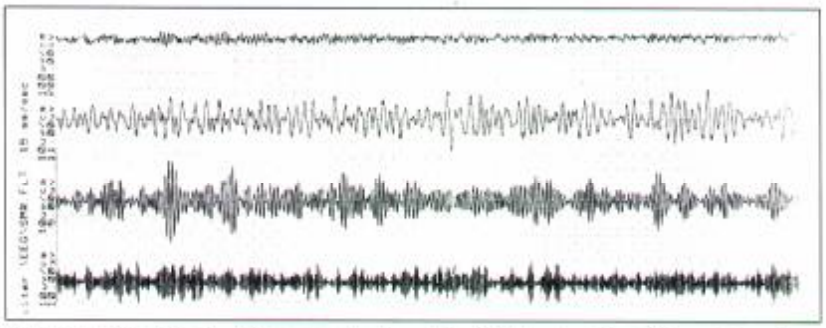

***Graph 2.*** *Patient No. 3. Electromyographic (EMG) evaluation of trapezius muscles activity. Upper Panel, Left trapezius (darker line) vs right trapezius (lighter line) shows higher activity overall on left side. Lower Panel, Left lateroposterior neck (darker line) vs right lateroposterior neck (lighter line). Observe constant higher muscle activity of left trapezius but higher resting muscle activity on right side of neck during muscle exercises.*




***Graph 3.*** *Patient No. 3. Electromyographic (EMG) evaluation at level of temporomandibular joints (TMJ). Upper Panel, Left TMJ (darker line) vs right TMJ (lighter line). Lower Panel, Ratio of left:right TMJ during muscle exercises. Observe insignificant difference in muscle activity between left and right TMJ.*



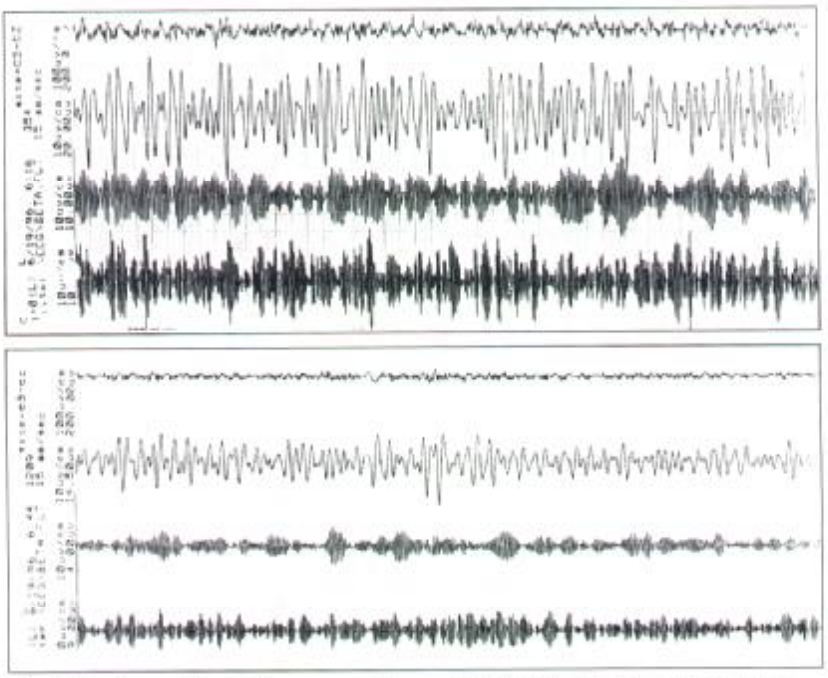
***Graph 4.*** *Patient No. 3. Initial electroencephalographic evaluation at C4 position (10/20 international system of electrode positioning) using Neurocybernetics instrument. Observe variability of amplitude of theta frequency (4-7 Hz) (second line from top), high amplitude of beta activity (12-18 Hz) (third line down), and normal high beta activity (22-30 Hz) (bottom line). At this time, pain level was rated as 9 (scale of 0 to 10) by the patient.*



***Graph 5.*** *Patient No. 3. Electroencephalographic (EEG) evaluation at C4 position after 20 sessions of EEG biofeedback. Observe stabilization and normalization of EEG. At this time, pain level was rated as 0 (scale of 0 to 10) by the patient.*

*Case 2.* C.L., a 50-year-old white female with a diagnosis of reflex sympathetic dystrophy, right facial nerve neuralgia, and MPS, was evaluated for biofeedback (Table 7, patient No. 1). Before biofeedback training, this patient had undergone surgery at the level of the cervical spine and had been prescribed hormonal medications for menopause, pain alleviators, and antidepressants. The PPP showed level-5 dysponetic use of the muscles (mainly on the right side of the body) and some somatization. However, the most important modifications were recorded with the EEG evaluation.

During EEG biofeedback training, it was observed that the left side of the brain (C3 position) showed the greatest variability at the outset of each session but was normalized by the end of each session (Graph 6) while the pain intensity decreased and the left eye opened (Figure 1). Correction of the ptosis of the left eye was previously observed after electrical stimulation. Depression and sleep disorder were also corrected.



***Graph 6.*** *Patient No. 1. Electroencephalographic (EEG) evaluation at C3 position. Top. At beginning of session when pain level was 10 and eye ptosis was evident (see also Figure 1, Left). Bottom. At end of session when pain level was 2-1 and eye was almost completely open (see also Figure 1, Right).*

***Figure 1.*** *Patient No. 1 during electroencephalographic session mentioned in Graph 6. Patient at start of training (left), after 15 minutes of training (center), and at end of training (right).*

## DISCUSSION

Chronic pain is a debilitating condition that impairs the performance of many individuals while still in the prime of life and may be coupled with sleep disorders and psychological disturbances. All the medical modalities developed to help reduce the intensity, duration, and occurrence of the pain are sometimes insufficient until patients learn to take control over their own emotions and sensations. Biofeedback was created to facilitate this process by increasing a patient's understanding of physiology and how emotions interact to create a vicious cycle of negative reinforcement. Relaxation techniques train patients to release unnecessary muscle tension, improve posture, and correct the dysponetic use of muscles, all of which is followed by a reduction in pain intensity. Another benefit of trained relaxation is an increase in peripheral TMP, which improves circulation through vasodilation and boosts elimination of pain-causing neurohormones. An effect on the central nervous system that facilitates the release of natural pain killers such as endorphins and enkephalins is also speculated.

Jacobs and Benson (1996) recorded the EEG brain mapping of the relaxation response. In their study, they mentioned that the frontal EEG beta activity decreases as a reaction to the relaxation response. These findings suggest the relaxation response produces significant reduction in the cortical activation in the anterior cortical areas. The peripheral physiologic modifications due to the relaxation response are secondary to the primary alteration within the central nervous system.

Neurofeedback training is based on repetitive mental activities for passively ignoring distracting thoughts and increasing body awareness followed by muscle relaxation. The consequences of these repetitive exercises are physiologic changes such as a reduction in heart rate, blood pressure, oxygen consumption, respiratory rate, and arterial blood lactate, as well as a decrease in the response to norepinephrine. Neurofeedback addresses the patient's level of mental arousal, normalizing levels that are too high or too low; therefore, it is a helpful modality in the treatment of medical disorders caused or exacerbated by sympathetic nervous system arousal, including headaches and other chronic pains, anxiety related to stressful procedures, sleep disorders, and high blood pressure.

Making the clinical distinction between MPS and fibromyalgia is important to rendering appropriate therapy. When the two disorders occur simultaneously, treatment becomes more complicated. Chronic fatigue syndrome, which is often also present, may further add to the complexity of management. The addition of neurofeedback to the classic therapeutic modalities—drugs, surgery, chiropractic medicine, physical therapy, and electrical stimulation—can be of significant benefit to patients.

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